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(54) **DISPLAY DEVICE AND METHOD FOR OPERATING SAME**

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CPC G09G 3/32; G09G 3/34; G09G 3/3406; G09G 3/3426; G09G 3/3618;
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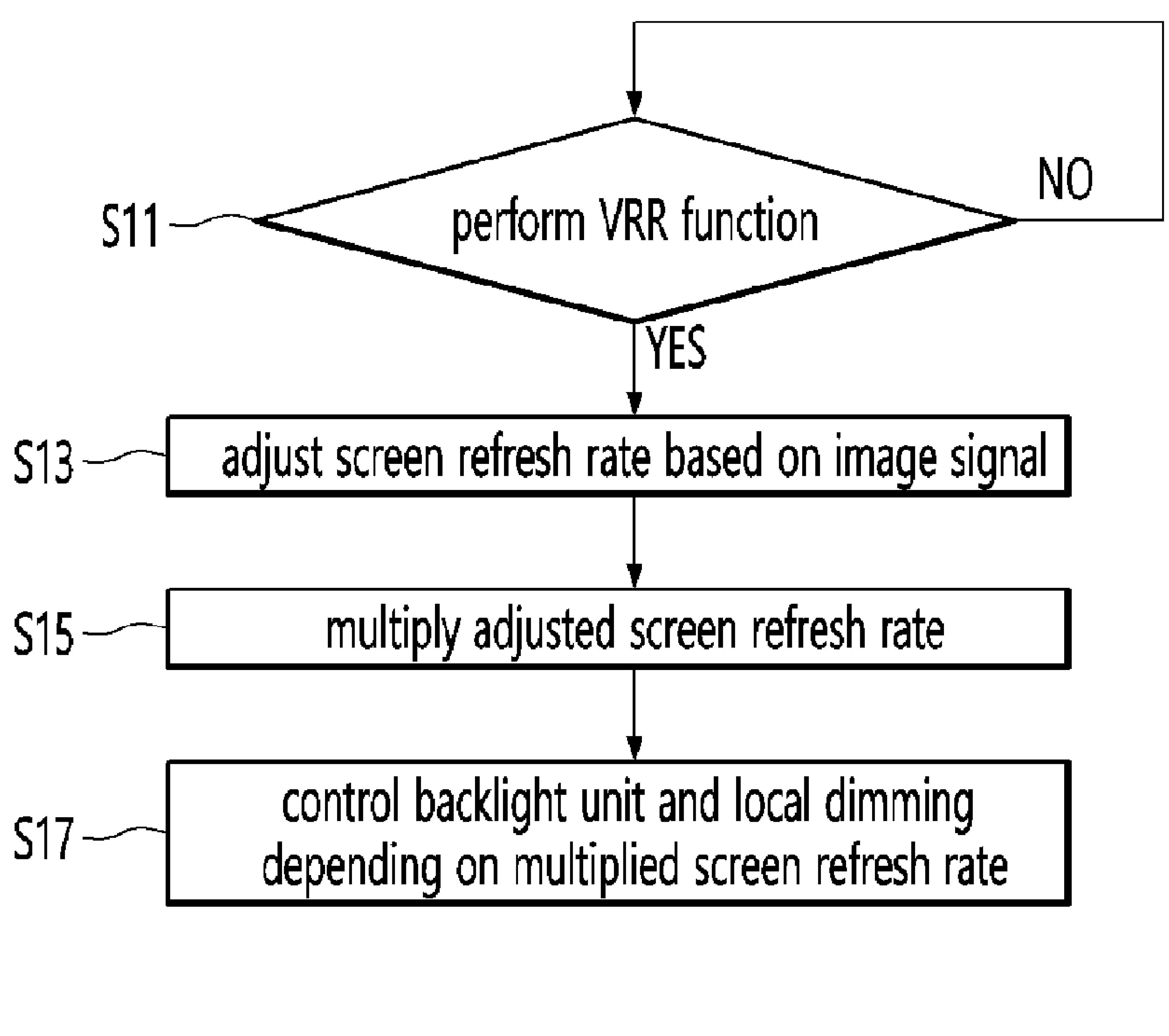
(57) **ABSTRACT**

The present invention relates to a display device having a more improved variable refresh rate (VRR) function, and comprises: a control unit for executing a variable refresh rate (VRR) function of adjusting a screen refresh rate according to an image signal; and a display unit for outputting an image according to the screen refresh rate, wherein the control unit can increase the screen refresh rate adjusted according to the image signal.

10 Claims, 13 Drawing Sheets



(52) **U.S. Cl.**
CPC ... ***G09G 3/3426*** (2013.01); *G09G 2310/0237* (2013.01); *G09G 2310/0264* (2013.01); *G09G 2320/0247* (2013.01); *G09G 2320/0252* (2013.01); *G09G 2320/0646* (2013.01); *G09G 2340/0435* (2013.01)

(58) **Field of Classification Search**
CPC ... G09G 2310/0237; G09G 2310/0264; G09G 2310/0243; G09G 2320/0247; G09G 2320/0646; G09G 2320/0252; G09G 2340/0435
USPC 345/204
See application file for complete search history.

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FIG. 1

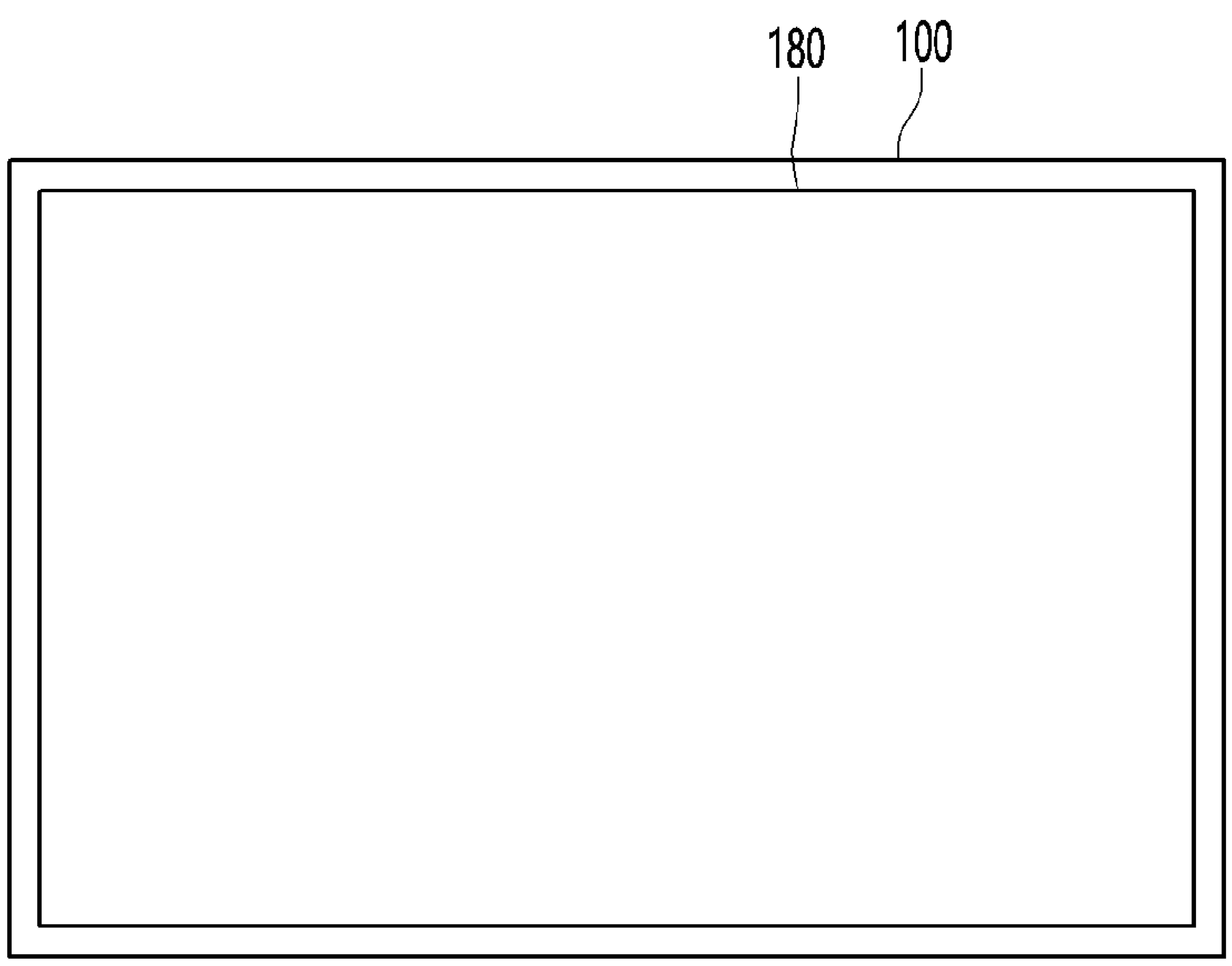


FIG. 2

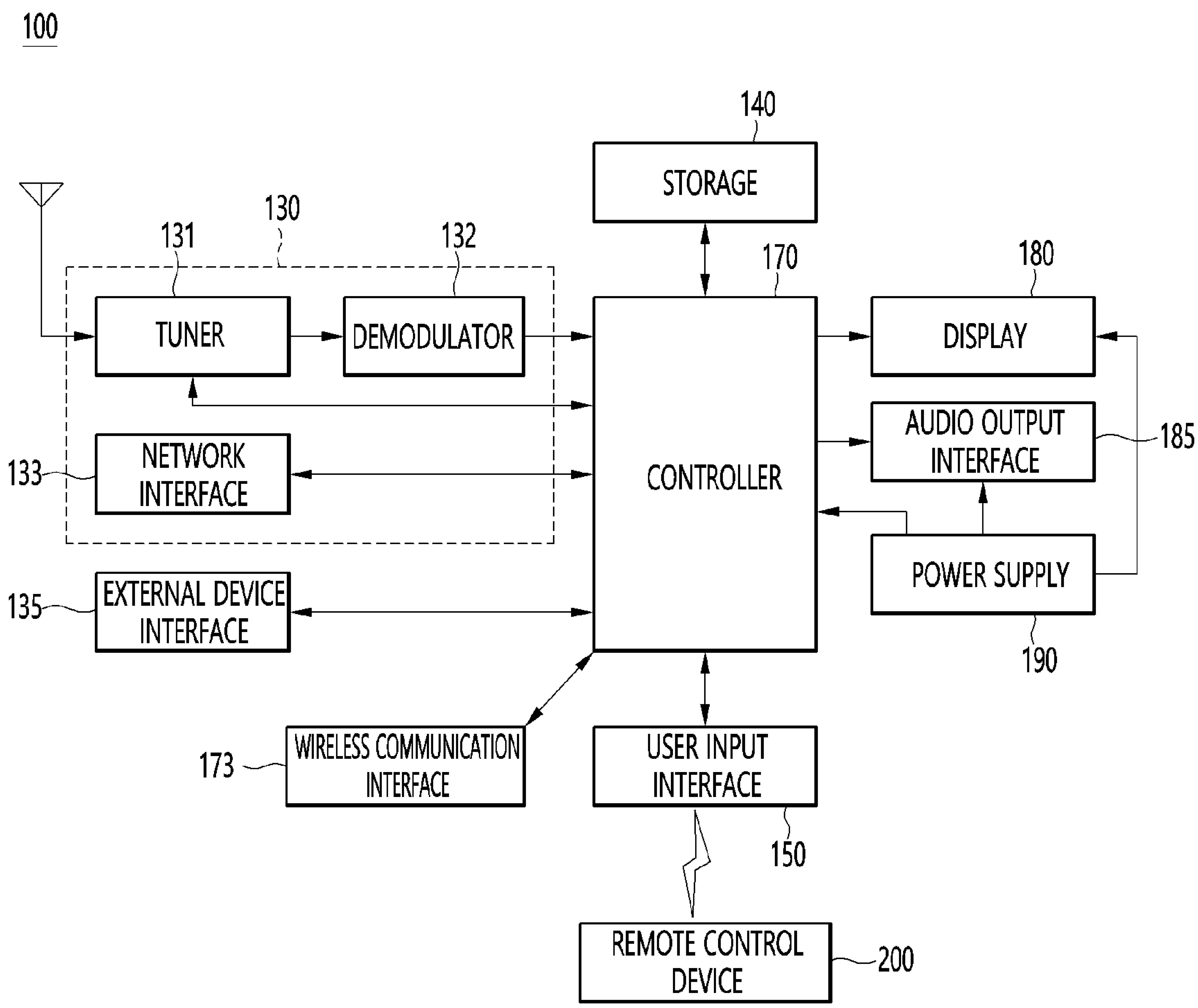

100
140
STORAGE
130
131
132
170
180
TUNER
DEMODULATOR
DISPLAY
AUDIO OUTPUT INTERFACE
185
133
NETWORK INTERFACE
CONTROLLER
POWER SUPPLY
135
EXTERNAL DEVICE INTERFACE
190
173
WIRELESS COMMUNICATION INTERFACE
USER INPUT INTERFACE
150
REMOTE CONTROL DEVICE
200

FIG. 3

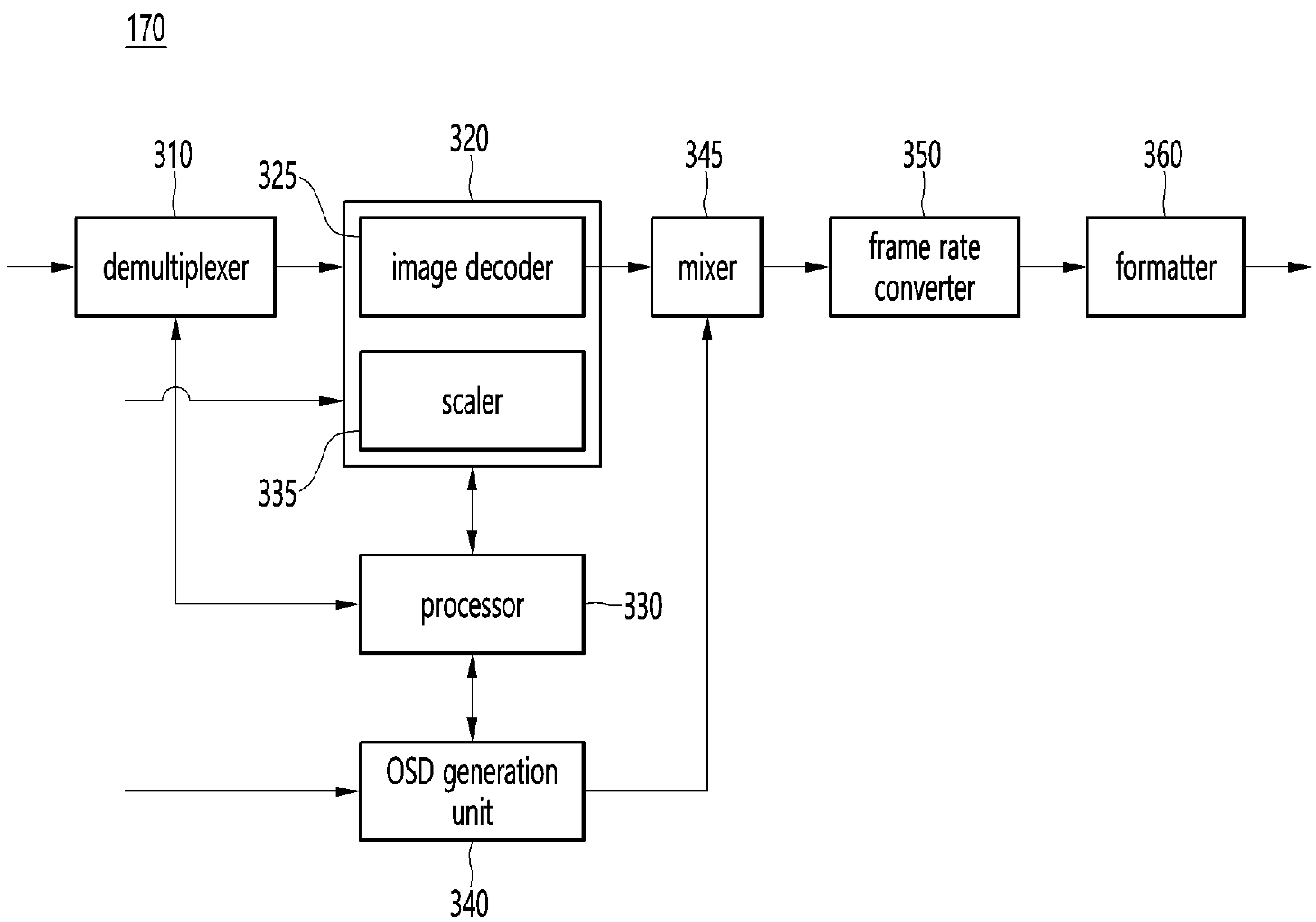

170
310
325
320
345
350
360
demultiplexer
image decoder
mixer
frame rate converter
formatter
scaler
335
processor
330
OSD generation unit
340

FIG. 4A

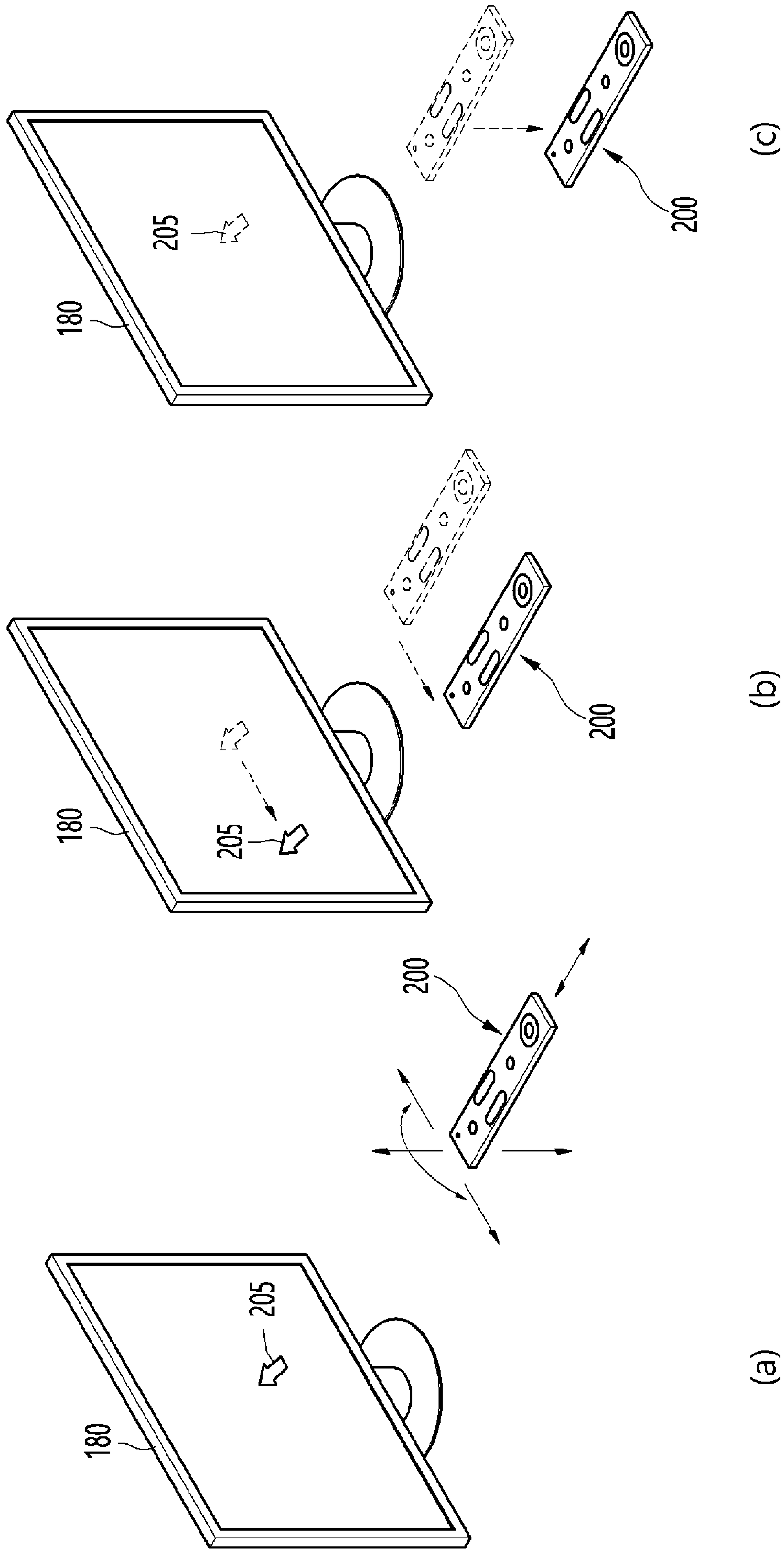


FIG. 4B

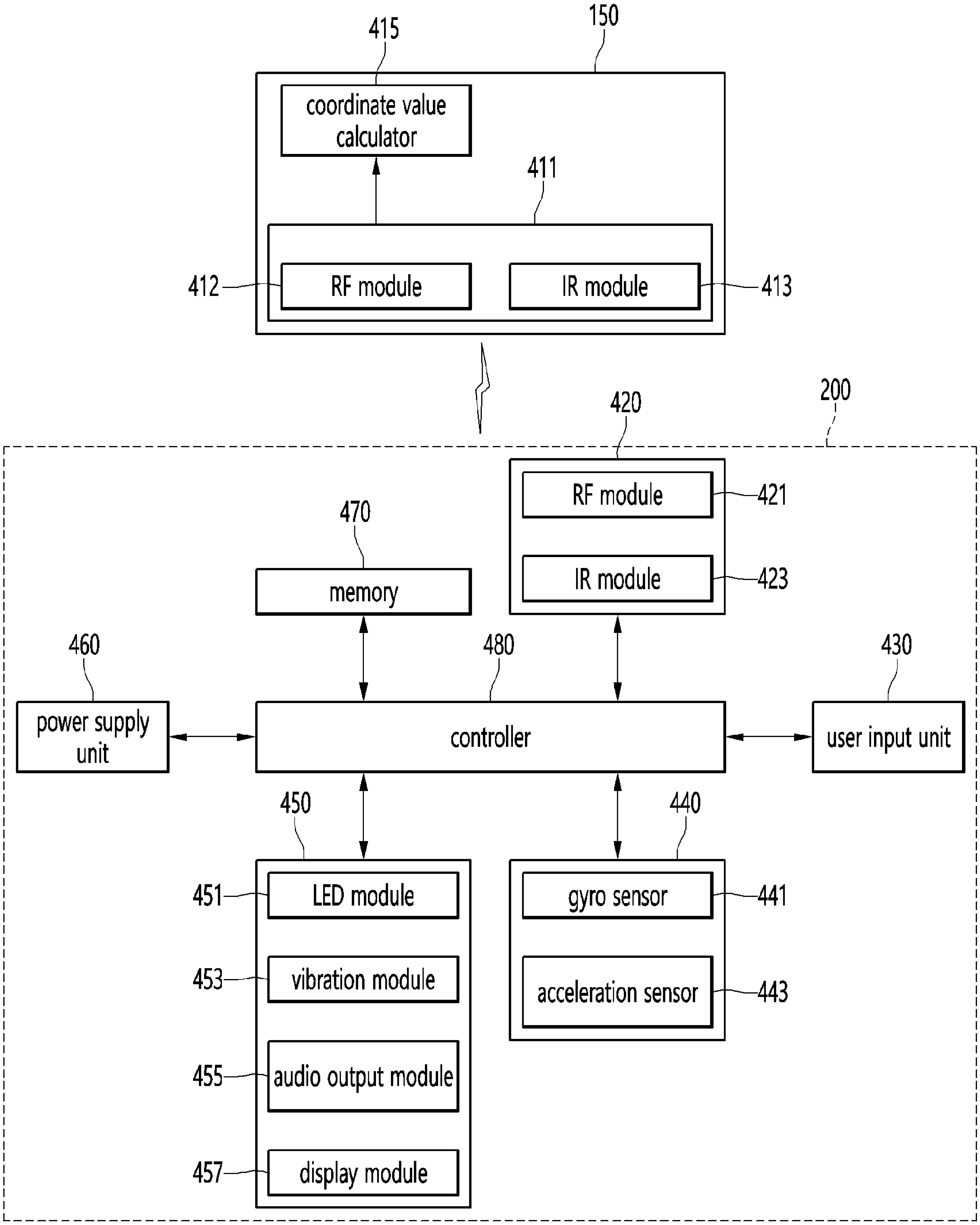

415
150
coordinate value calculator
411
412
RF module
IR module
413
420
200
RF module
421
470
IR module
423
memory
460
480
430
power supply unit
controller
user input unit
450
440
451
LED module
gyro sensor
441
453
vibration module
acceleration sensor
443
455
audio output module
457
display module

FIG. 5

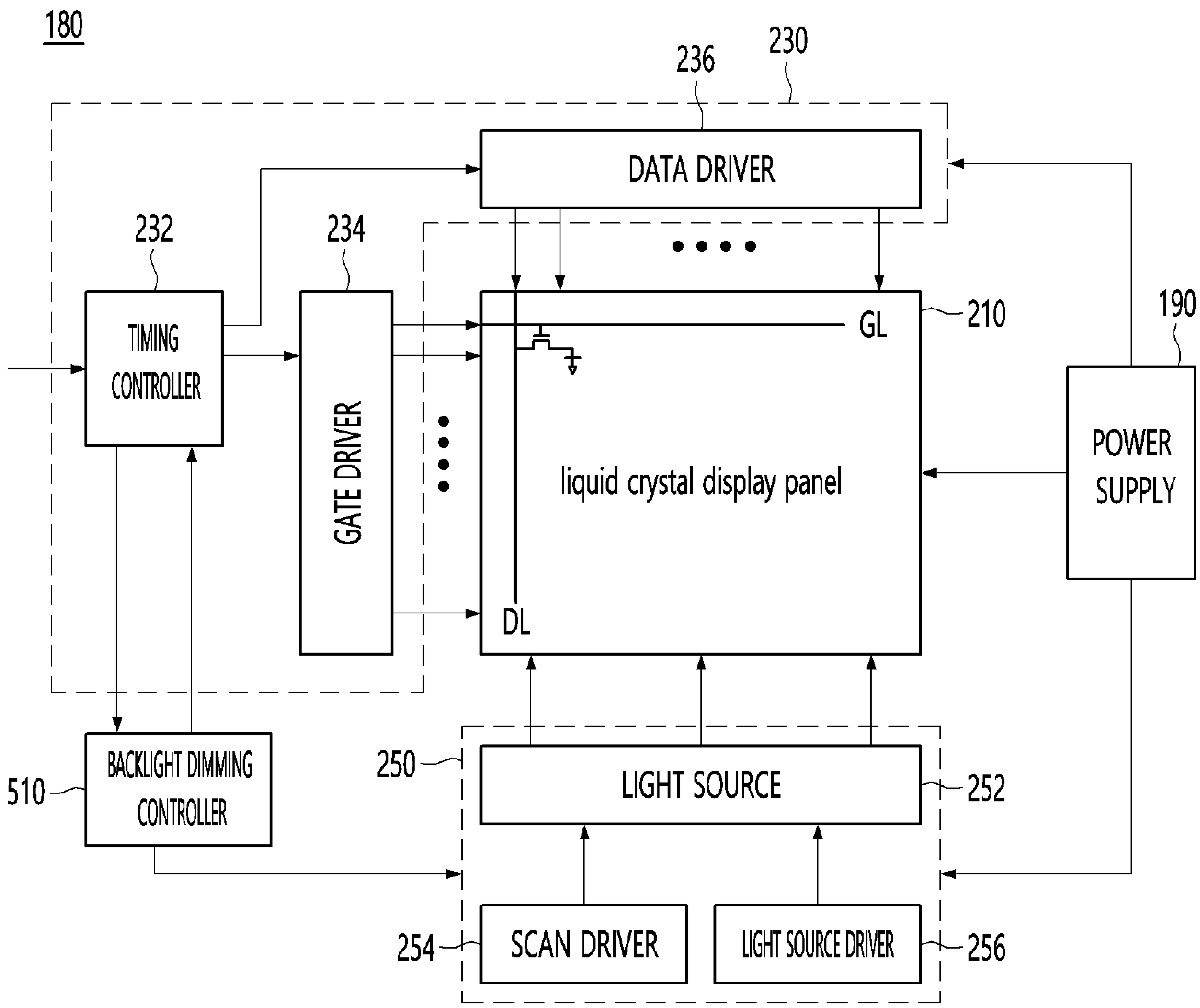
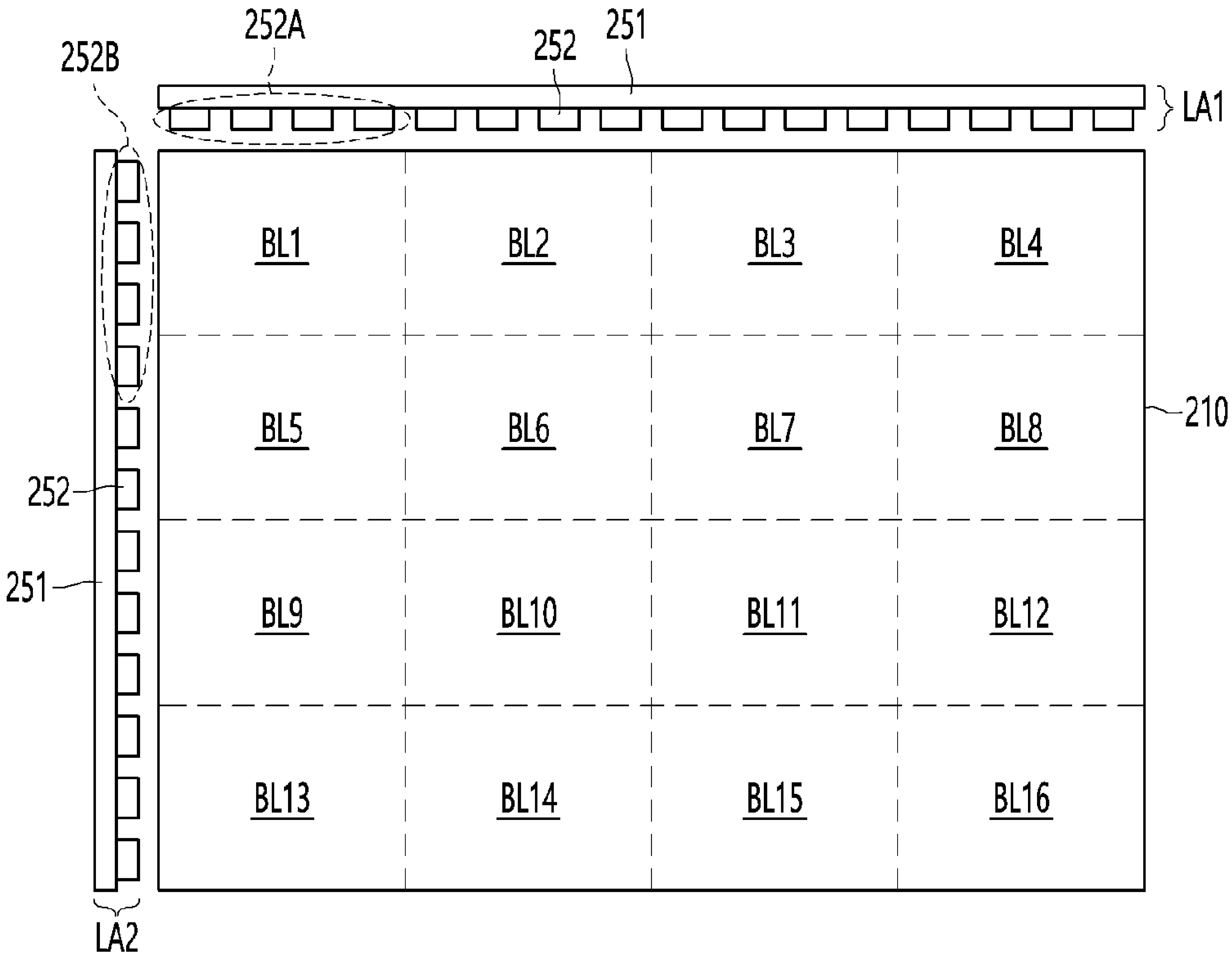

180
236
230
DATA DRIVER
232
234
TIMING CONTROLLER
GATE DRIVER
GL
210
190
liquid crystal display panel
POWER SUPPLY
DL
250
LIGHT SOURCE
252
510
BACKLIGHT DIMMING CONTROLLER
254
SCAN DRIVER
LIGHT SOURCE DRIVER
256

FIG. 6


252A
252B
252
251
LA1
BL1
BL2
BL3
BL4
BL5
BL6
BL7
BL8
BL9
BL10
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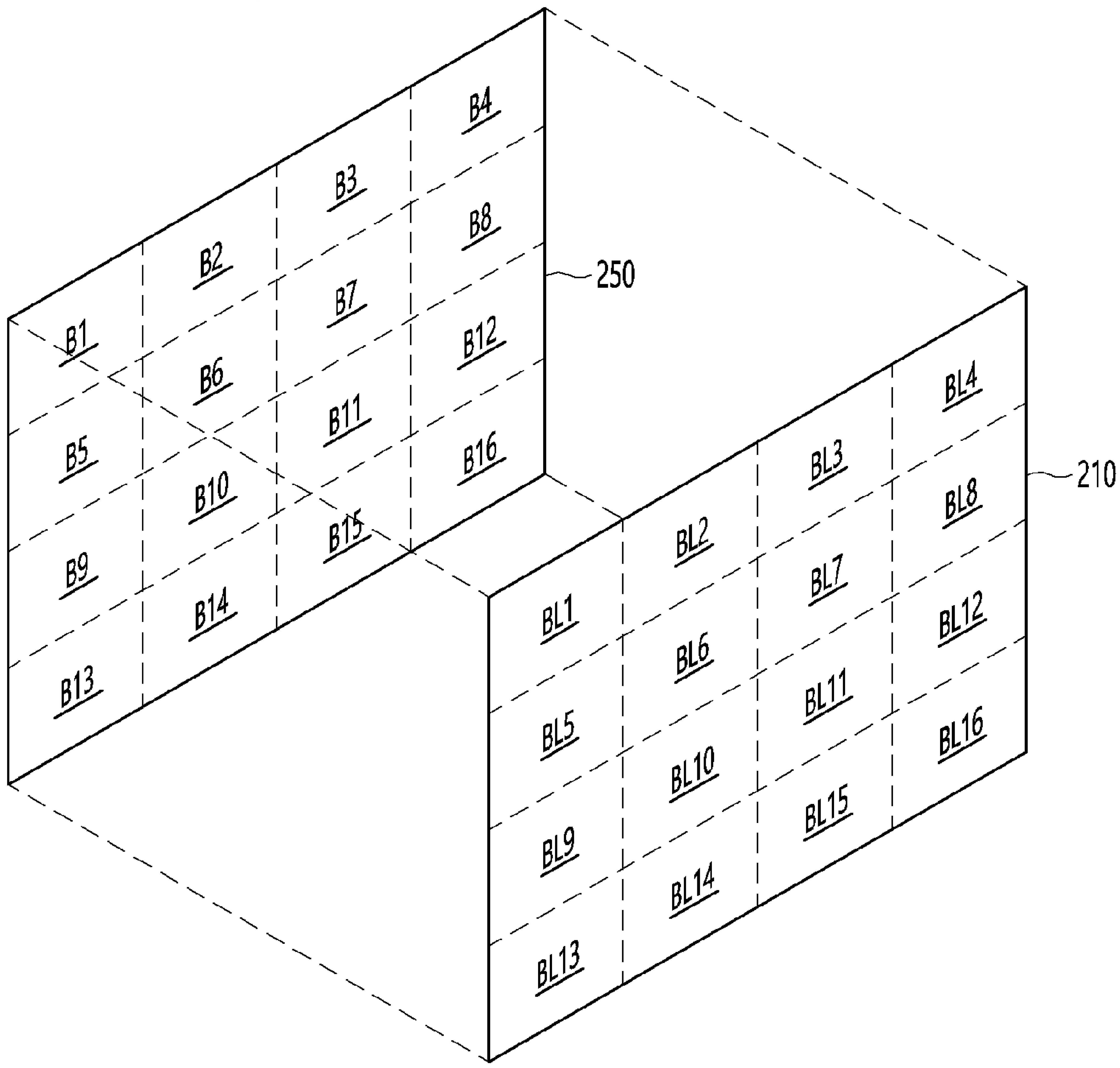
BL13
BL14
BL15
BL16
210
252
251
LA2

FIG. 7


B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
B15
B16
250
BL1
BL2
BL3
BL4
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BL10
BL11
BL12
BL13
BL14
BL15
BL16
210

FIG. 8

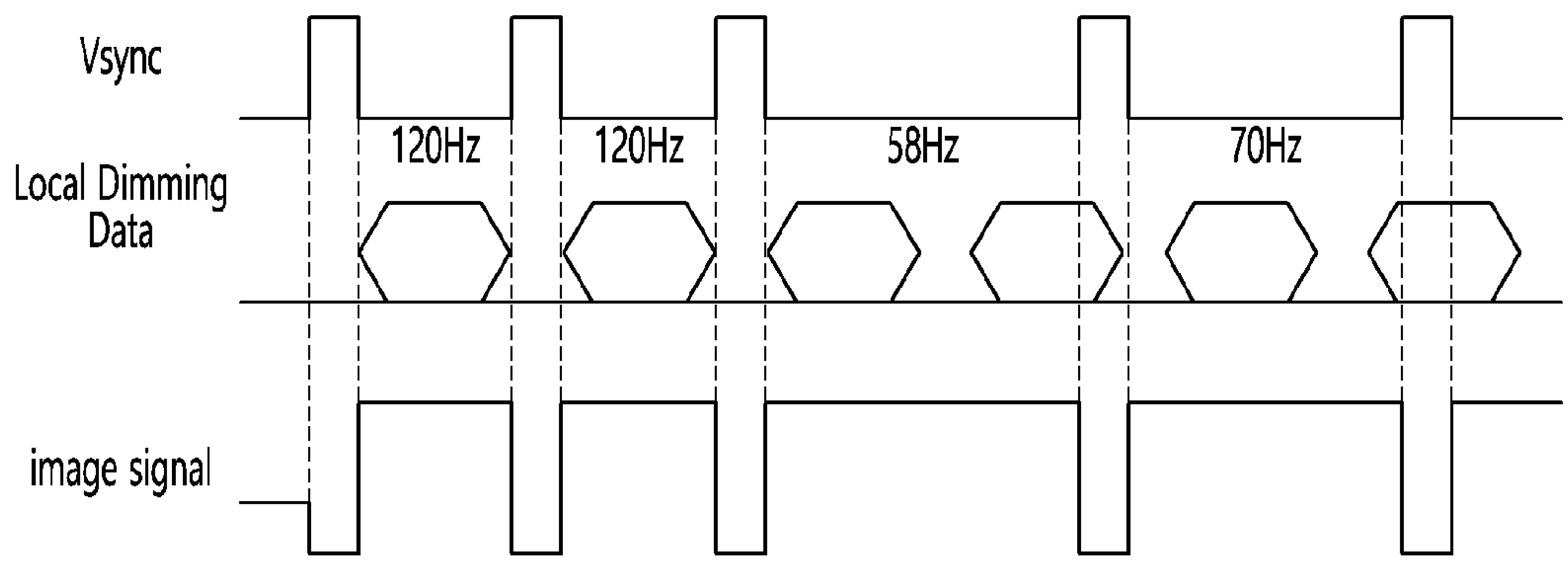

Vsync
Local Dimming Data
image signal
120Hz
120Hz
58Hz
70Hz

FIG. 9

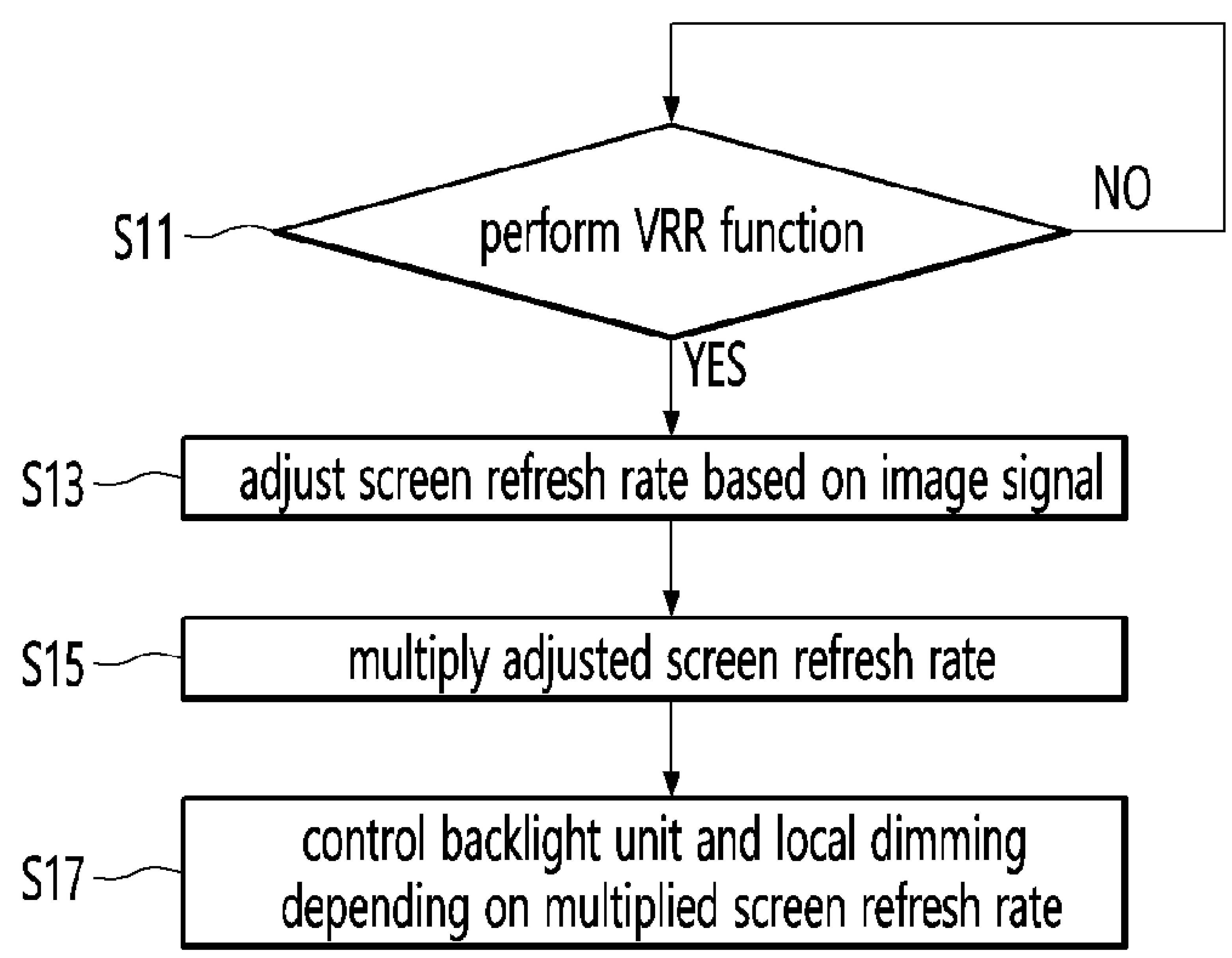

perform VRR function
NO
YES
S11
adjust screen refresh rate based on image signal
S13
multiply adjusted screen refresh rate
S15
control backlight unit and local dimming depending on multiplied screen refresh rate
S17

FIG. 10

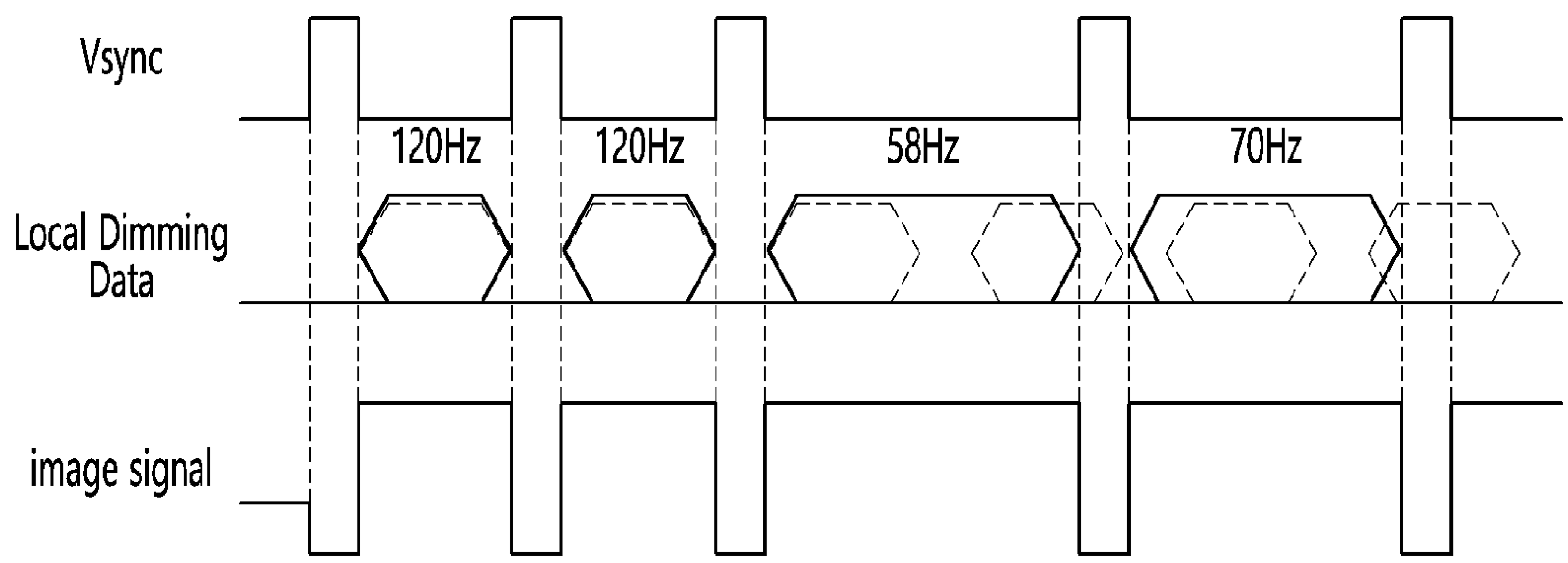

Vsync
120Hz
120Hz
58Hz
70Hz
Local Dimming Data
image signal

FIG. 11

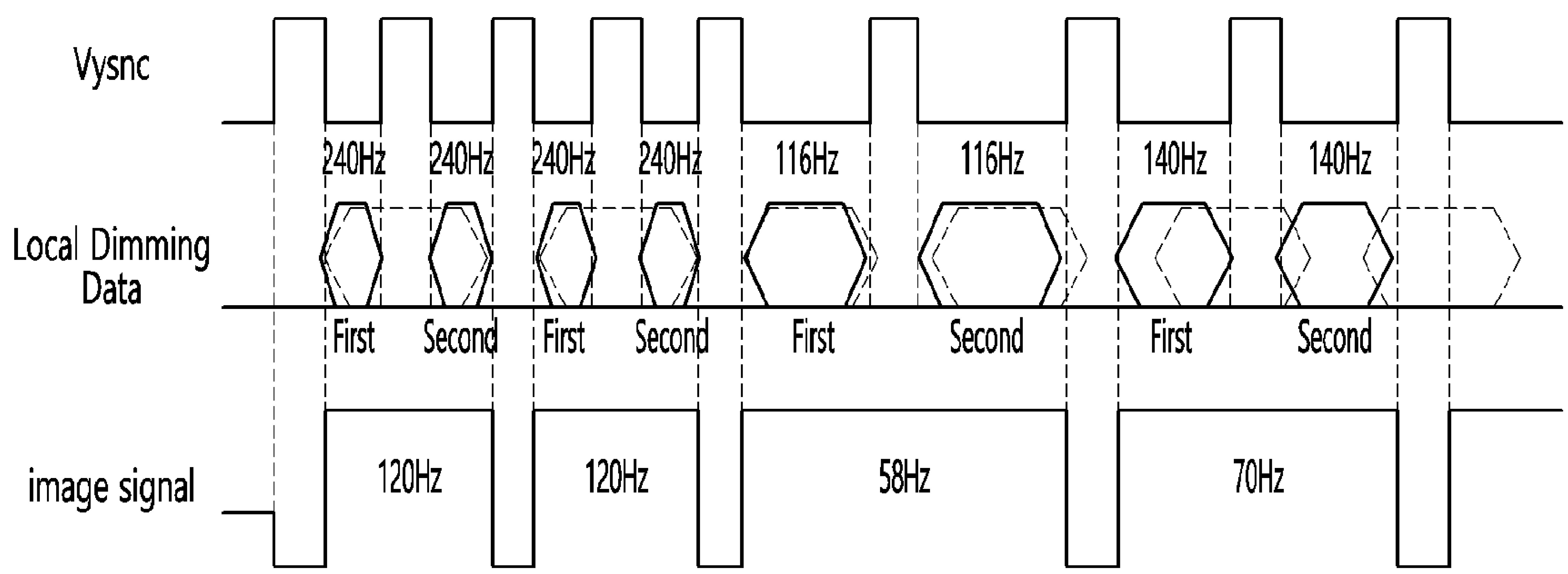
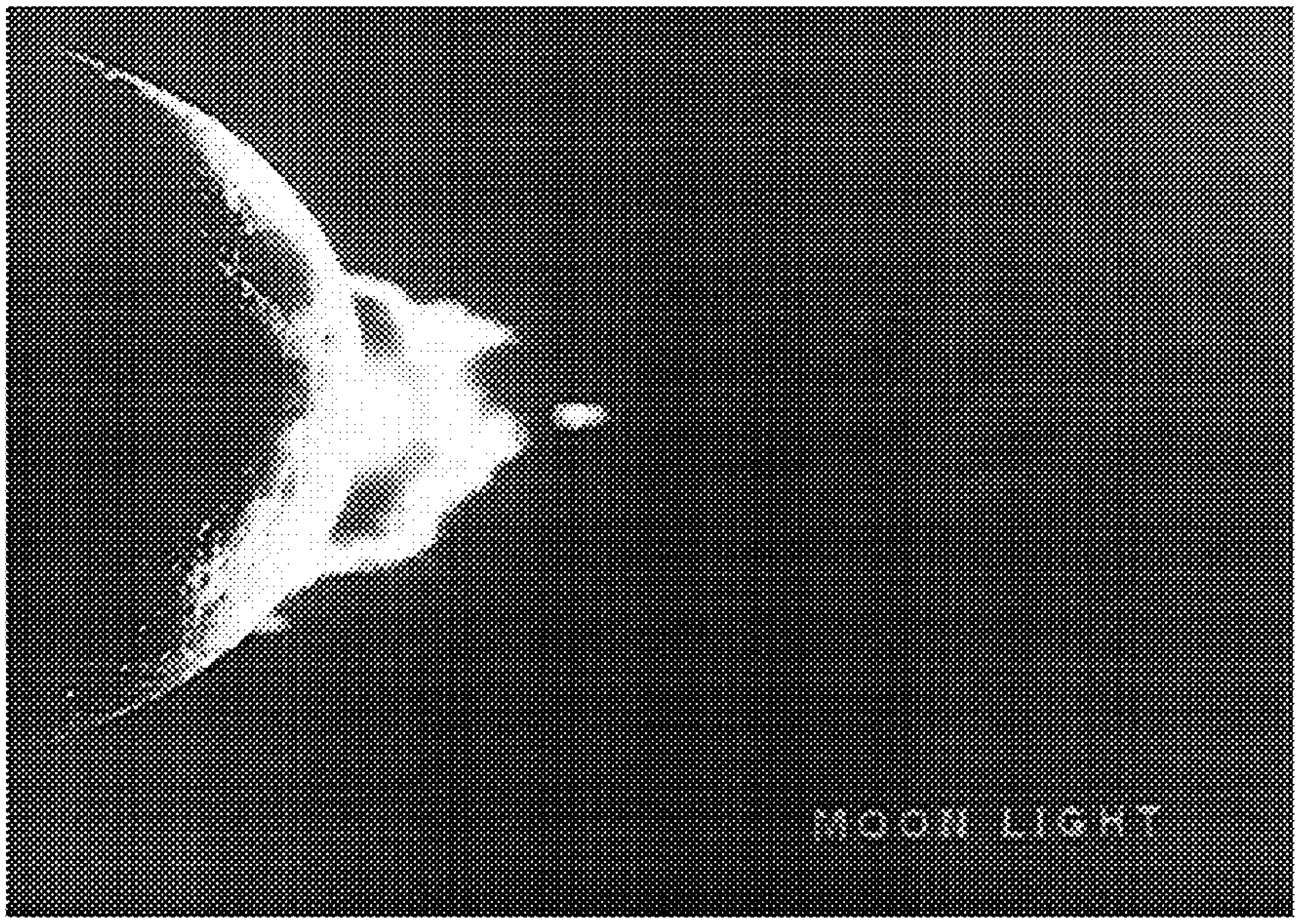

Vysnc
240Hz
240Hz
240Hz
240Hz
116Hz
116Hz
140Hz
140Hz
Local Dimming Data
First
Second
First
Second
First
Second
First
Second
image signal
120Hz
120Hz
58Hz
70Hz

FIG. 12



(a)

(b)

DISPLAY DEVICE AND METHOD FOR OPERATING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is the National Stage filing under 35 U.S.C. 371 of International Application No. PCT/KR2019/010560, filed on Aug. 20, 2019, the contents of which are all incorporated by reference herein in its entirety.

TECHNICAL FIELD

The present disclosure relates to a display device and a method for operating the same, and more particularly, to a display device having an improved variable refresh rate (VRR) function and a method for operating the same.

BACKGROUND ART

A variable refresh rate (VRR) function may be a function of synchronizing a source with a display device to provide an environment which is more flexible and provides details in a game mode.

Such a VRR function is referred to as FreeSync or G-Sync depending on a developing company.

The display device may support the VRR function to output an image to a screen in synchronization with timing of receiving an image frame, thereby reducing Screen Tearing caused, as a frame rate of the image is mismatched from a refresh rate.

In the VRR function, the screen refresh rate of the display device may be adjusted to be in the range of about 48 Hz to 120 Hz. In this case, when the screen refresh rate is adjusted to be excessively lowered, even an operating frequency of a backlight unit is lowered, thereby causing a flicker phenomenon.

In addition, even though the screen refresh rate is adjusted, local dimming is not controlled in real time. Accordingly, the local dimming mismatched from an output image is performed, so a contrast ratio is not optimized.

DISCLOSURE

Technical Problem

The present disclosure is to provide a display device capable of minimizing a flicker phenomenon in a VRR function, and a method for operating the same.

The present disclosure is to provide a display device capable of controlling local dimming to be matched to an output image in a VRR function, and a method for operating the same.

Technical Solution

A display device according to an embodiment of the present disclosure comprises a controller configured to perform a variable refresh rate (VRR) function of adjusting a screen refresh rate depending on an image signal, and a display configured to output an image depending on the screen refresh rate, wherein the controller is configured to increase the screen refresh rate adjusted depending on the image signal.

The controller multiples the screen refresh rate adjusted depending on the image signal.

The controller is configured to increase the screen refresh rate, when the screen refresh rate adjusted depending on the image signal is equal to or less than a preset frequency.

The preset frequency is 55 Hz.

The controller is configured to maintain the screen refresh rate adjusted depending on the image signal, when the screen refresh rate adjusted depending on the image signal exceeds the preset frequency.

The controller is configured to extract a frequency of a vertical synchronizing signal, based on the number of frames per second of the image signal, and increase the screen refresh rate based on the frequency of the vertical synchronizing signal.

The controller is configured to increase an operating frequency of a backlight unit provided in the display unit by increasing the screen refresh rate.

The controller is configured to apply only local dimming data, which is first calculated, to the display, when multiplying the frequency for calculating the local dimming data.

The controller is configured to prevent only local dimming data, which is second calculated, from being applied to the display, when multiplying the frequency for calculating the local dimming data.

The display device further comprising an external device interface connected to an external device, wherein the controller is configured to perform the VRR function, when receiving the image signal from the external device.

The controller includes an image decoder to acquire the number of frames per second of an image signal by decoding the image signal, and to acquire a screen refresh rate based on the number of frames per second, and a frame rate converter to increase the screen refresh rate acquired through the image decoder, and wherein the display includes a backlight unit and a backlight dimming controller driven depending on the screen refresh rate increased through the frame rate converter.

The controller is configured to increase the screen refresh rate to a second frequency higher than a first frequency, when acquiring the screen refresh rate to the first frequency, based on the image signal.

The controller is configured to fix the screen refresh rate, when the VRR function is not performed.

An operating method of a display device according to an embodiment of present disclosure comprises receiving an image signal, performing a variable refresh rate (VRR) function of adjusting a screen refresh rate depending on the image signal, increasing the screen refresh rate adjusted depending on the image signal, and outputting an image depending on the increased screen refresh rate.

Advantageous Effects

According to an embodiment of the present disclosure, the flicker phenomenon may be minimized when the VRR function is performed, thereby minimizing inconvenience of the user.

In addition, the local dimming may be applied to be matched to the output image, even when the VRR function is performed, thereby improving the contrast ratio and improving image quality.

In addition, the screen refresh rate may be increased only wider a specific condition, when the VRR function is performed. In this case, the unnecessary data processing may be minimized, thereby reducing an image processing load.

DESCRIPTION OF DRAWINGS

FIG. **1** is a diagram illustrating a display device according to an embodiment of the present invention.

FIG. 2 is a block diagram illustrating the configuration of the display device of FIG. 1.

FIG. 3 is an example of a block diagram of the inside of a controller in FIG. 2.

FIG. 4A is a diagram illustrating a method in which the remote controller in FIG. 2 performs control.

FIG. 4B is a block diagram of the inside of the remote controller in FIG. 2.

FIG. 5 is a block diagram illustrating an inner part of the power supply and the display of FIG. 2.

FIG. 6 is a view illustrating a liquid crystal display panel and the arrangement of light sources in the case of an edge type backlight unit.

FIG. 7 is a view illustrating a liquid crystal display panel and the arrangement of light sources in the case of a direct type backlight unit.

FIG. 8 is a view illustrating a method in which the display device controls a vertical synchronizing signal and local dimming, based on an image signal while performing a VRR function.

FIG. 9 is a flowchart illustrating an operating method of a display device according to an embodiment of the present disclosure.

FIG. 10 is a view illustrating output timing of a vertical synchronizing signal Vsync and local dimming data depending on an image signal while a display device is performing the VRR function according to an embodiment of the present disclosure.

FIG. 11 is a view illustrating output timing of a vertical synchronizing signal Vsync and local dimming data, after multiplying the vertical synchronizing signal Vsync depending on an image signal, while a display device performs a VRR function according to an embodiment of the present disclosure.

FIG. 12 is a view illustrating an image when a screen refresh rate, which is adjusted, is not increased or an image when a screen refresh rate is increased, after the screen refresh rate is adjusted when a display device is performing a VRR function according to an embodiment of the present disclosure.

BEST MODE

Mode for Invention

Hereinafter, the present invention will be described in detail with reference to the drawings.

The suffixes "module" and "unit" for components used in the description below are assigned or mixed in consideration of easiness in writing the specification and do not have distinctive meanings or roles by themselves.

Terms including ordinal numbers such as first and second may be used to describe various elements, but the elements are not limited by the terms. The terms are only used for the purpose of distinguishing one component from another component.

The singular expression includes the plural expression unless the context clearly dictates otherwise.

In the present application, terms such as "comprises" or "have" are intended to designate that a feature, number, step, operation, component, part, or combination thereof described in the specification exists, but one or more other features It should be understood that this does not preclude the existence or addition of numbers, steps, operations, components, parts, or combinations thereof.

FIG. 1 is a diagram illustrating a display device according to an embodiment of the present invention.

With reference to the drawings, a display device **100** includes a display **180**.

On the other hand, the display **180** is realized by one among various panels. For example, the display **180** is one of the following panels: a liquid crystal display panel (LCD panel), an organic light-emitting diode (OLED) panel (OLED panel), and an inorganic light-emitting diode (OLED) panel (IUD panel).

According to the present disclosure, the display **180** includes a liquid crystal display panel (LCD panel). Hereinafter, the display device **100** may be a liquid crystal display device.

On the other hand, examples of the display device **100** in FIG. 1 include a monitor, a TV, a tablet PC, a mobile terminal, and so on.

FIG. 2 is a block diagram illustrating the configuration of the display device of FIG. 1.

Referring to FIG. 2, a display device **100** can include a broadcast reception module **130**, an external device interface **135**, a storage **140**, a user input interface **150**, a controller **170**, a wireless communication interface **173**, a display **180**, an audio output interface **185**, and a power supply **190**.

The broadcast reception module **130** can include a tuner **131**, a demodulator **132**, and a network interface **133**.

The tuner **131** can select a specific broadcast channel according to a channel selection command. The tuner **131** can receive broadcast signals for the selected specific broadcast channel.

The demodulator **132** can divide the received broadcast signals into video signals, audio signals, and broadcast program related data signals and restore the divided video signals, audio signals, and data signals to an output available form.

The network interface **133** can provide an interface for connecting the display device **100** to a wired/wireless network including internet network. The network interface **133** can transmit or receive data to or from another user or another electronic device through an accessed network or another network linked to the accessed network.

The network interface **133** can access a predetermined webpage through an accessed network or another network linked to the accessed network. That is, it can transmit or receive data to or from a corresponding server by accessing a predetermined webpage through network.

Then, the network interface **133** can receive contents or data provided from a content provider or a network operator. That is, the network interface **133** can receive contents such as movies, advertisements, games, VODs, and broadcast signals, which are provided from a content provider or a network provider, through network and information relating thereto.

Additionally, the network interface **133** can receive firmware update information and update files provided from a network operator and transmit data to an interact or content provider or a network operator.

The network interface **133** can select and receive a desired application among applications open to the air, through network.

The external device interface **135** can receive an application or an application list in an adjacent external device and deliver it to the controller **170** or the storage **140**.

The external device interface **135** can provide a connection path between the display device **100** and an external device. The external device interface **135** can receive at least one of image and audio outputted from an external device that is wirelessly or wiredly connected to the display device **100** and deliver it to the controller. The external device interface **135** can include a plurality of external input terminals. The plurality of external input terminals can include an RGB terminal, at least one High Definition Multimedia Interface (HDMI) terminal, and a component terminal.

An image signal of an external device inputted through the external device interface **135** can be outputted through the display **180**. A sound signal of an external device inputted through the external device interface **135** can be outputted through audio output interface **185**.

An external device connectable to the external device interface **135** can be one of a set-top box, a Blu-ray player, a DVD player, a game console, a sound bar, a smartphone, a PC, a USB Memory, and a home theater system but this is just exemplary.

Additionally, some content data stored in the display device **100** can be transmitted to a user or an electronic device, which is selected from other users or other electronic devices pre-registered in the display device **100**.

The storage **140** can store signal-processed image, voice, or data signals stored by a program in order for each signal processing and control in the controller **170**.

Additionally, the storage **140** can perform a function for temporarily store image, voice, or data signals outputted from the external device interface **135** or the network interface **133** and can store information on a predetermined image through a channel memory function.

The storage **140** can store an application or an application list inputted from the external device interface **135** or the network interface **133**.

The display device **100** can play content files (for example, video files, still image files, music files, document files, application files, and so on) stored in the storage **140** and provide them to a user.

The user input interface **150** can deliver signals inputted from a user to the controller **170** or deliver signals from the controller **170** to a user. For example, the user input interface **150** can receive or process control signals such as power on/off, channel selection, and screen setting from the remote control device **200** or transmit control signals from the controller **170** to the remote control device **200** according to various communication methods such as Bluetooth, Ultra Wideband (WB), ZigBee, Radio Frequency (RF), and IR.

Additionally, the user input interface **150** can deliver, to the controller **170**, control signals inputted from local keys (not shown) such as a power key, a channel key, a volume key, and a setting key.

Image signals that are image-processed in the controller **170** can be inputted to the display **180** and displayed as an image corresponding to corresponding image signals. Additionally, image signals that are image-processed in the controller **170** can be inputted to an external output device through the external device interface **135**.

Voice signals processed in the controller **170** can be outputted to the audio output interface **185**. Additionally, voice signals processed in the controller **170** can be inputted to an external output device through the external device interface **135**.

Besides that, the controller **170** can control overall operations in the display device **100**.

Additionally, the controller **170** can control the display device **100** by a user command or internal program inputted through the user input interface **150** and download a desired application or application list into the display device **100** in access to network.

The controller **170** can output channel information selected by a user together with processed image or voice signals through the display **180** or the audio output interface **185**.

Additionally, according to an external device image playback command received through the user input interface **150**, the controller **170** can output image signals or voice signals of an external device such as a camera or a camcorder, which are inputted through the external device interface **135**, through the display **180** or the audio output interface **185**.

Moreover, the controller **170** can control the display **180** to display images and control broadcast images inputted through the tuner **131**, external input images inputted through the external device interface **135**, images inputted through the network interface, or images stored in the storage **140** to be displayed on the display **180**. In this case, an image displayed on the display **180** can be a still image or video and also can be a 2D image or a 3D image.

Additionally, the controller **170** can play content stored in the display device **100**, received broadcast content, and external input content inputted from the outside, and the content can be in various formats such as broadcast images, external input images, audio files, still images, accessed web screens, and document files.

Moreover, the wireless communication interface **173** can perform a wired or wireless communication with an external electronic device. The wireless communication interface **173** can perform short-range communication with an external device. For this, the wireless communication interface **173** can support short-range communication by using at least one of Bluetooth™, Radio Frequency identification (RFID), Infrared Data Association (IrDA), Ultra Wideband (UWB), ZigBee, Near Field Communication (NFC), Wireless-Fidelity (Wi-Fi), Direct, and Wireless Universal Serial Bus (USB) technologies. The wireless communication interface **173** can support wireless communication between the display device **100** and a wireless communication system, between the display device **100** and another display device **100**, or between networks including the display device **100** and another display device **100** (or an external server) through wireless area networks. The wireless area networks can be wireless personal area networks.

Herein, the other display device **100** can be a mobile terminal such as a wearable device (for example, a smart watch, a smart glass, and a head mounted display (HMD)) or a smartphone, which is capable of exchanging data (or inter-working) with the display device **100**. The wireless communication interface **173** can detect (or recognize) a communicable wearable device around the display device **100**. Furthermore, if the detected wearable device is a device authenticated to communicate with the display device **100**, the controller **170** can transmit at least part of data processed in the display device **100** to the wearable device through the wireless communication interface **173**. Accordingly, a user of the wearable device can use the data processed in the display device **100** through the wearable device.

The display **180** can convert image signals, data signals, or OSD signals, which are processed in the controller **170**, or images signals or data signals, which are received in the external device interface **135**, into R, G, and B signals to generate driving signals.

Furthermore, the display device **100** shown in FIG. **2** is just one embodiment of the present disclosure and thus, some of the components shown can be integrated, added, or omitted according to the specification of the actually implemented display device **100**.

That is, if necessary, two or more components can be integrated into one component or one component can be divided into two or more components and configured. Additionally, a function performed by each block is to describe an embodiment of the present disclosure and its specific operation or device does not limit the scope of the present disclosure.

According to another embodiment of the present disclosure, unlike FIG. **2**, the display device **100** can receive images through the network interface **133** or the external device interface **135** and play them without including the tuner **131** and the demodulator **132**.

For example, the display device **100** can be divided into an image processing device such as a set-top box for receiving broadcast signals or contents according to various network services and a content playback device for playing contents inputted from the image processing device.

In this case, an operating method of a display device according to an embodiment of the present disclosure described below can be performed by one of the display device described with reference to FIG. **2**, an image processing device such as the separated set-top box, and a content playback device including the display **180** and the audio output interface **185**.

The audio output interface **185** receives a signal which is voice-processed by the controller **170**.

A power supply **190** supplies relevant power throughout the display device **100**. In particular, the power supply **190** may supply power to the controller **170**, which is implemented in the form of a system on chip (SoC), the display **180** to display an image, and the audio output interface **185** for an audio output.

In detail, the power supply **190** may include a converter, which converts alternating current (AC) power to direct current (DC) power, and a dc/dc converter which converts the level of the DC power.

The remote controller **200** transmits a user input to a user input interface **150**. To this end, the remote controller **200** may employ Bluetooth, radio frequency (RF) communication, infrared communication, ultra wideband, or ZigBee. Alternatively, the remote controller **200** may receive an image, a voice, or a data signal output from the user input interface **150**, may display the image, the voice, or the data signal to the remote controller **200**, and may output voice.

FIG. **3** is an example of a block diagram of the inside of a controller in FIG. **2**.

For description with reference to the drawings, the controller **170** according to an embodiment of the present invention includes a demultiplexer **310**, an image processing unit **320**, a processor **330**, an OSD generation unit **340**, a mixer **345**, a frame rate converter **350**, and a formatter **360**. In addition, an audio processing unit (not illustrated) and a data processing unit (not illustrated) are further included.

The demultiplexer **310** demultiplexes a stream input. For example, in a case where an MPEG-2 TS is input, the MPEG-2 TS is demultiplexed into an image signal, an audio signal, and a data signal. At this point, a stream signal input into the demultiplexer **310** is a stream signal output from the tuner **131**, the demodulator **132**, or the external device interface **135**.

The image processing unit **320** performs image processing of the image signal that results from the demultiplexing. To do this, the image processing unit **320** includes an image decoder **325** or a scaler **335**.

The image decoder **325** decodes the image signal that results from the demultiplexing. The scaler **335** performs scaling in such a manner that a resolution of an image signal which results from the decoding is such that the image signal is possibly output to the display **180**.

Examples of the image decoder **325** possibly include decoders in compliance with various specifications. For example, the examples of the image decoder **325** include a decoder for MPEG-2, a decoder for H.264, a 3D image decoder for a color image and a depth image, a decoder for a multi-point image, and so on.

The processor **330** controls an overall operation within the display device **100** or within the controller **170**. For example, the processor **330** controls the tuner unit **110** in such a manner that the tuner unit **110** performs the selection of (tuning to) the RF broadcast that corresponds to the channel selected by the user or the channel already stored.

In addition, the processor **330** controls the display device **100** using the user command input through the user input interface **150**, or the internal program.

In addition, the processor **330** performs control of transfer of data to and from the network interface **133** or the external device interface **135**.

In addition, the processor **330** controls operation of each of the demultiplexer **310**, the image processing unit **320**, the OSD generation unit **340**, and so on within the controller **170**.

The OSD generation unit **340** generates an OSD signal, according to the user input or by itself. For example, based on the user input signal, a signal is generated for displaying various pieces of information in a graphic or text format on a screen of the display **180**. The OSD signal generated includes various pieces of data for a user interface screen of the display device **100**, various menu screens, a widget, an icon, and so on. In addition, the OSD generated signal includes a 2D object or a 3D object.

In addition, based on a pointing signal input from the remote controller **200**, the OSD generation unit **340** generates a pointer possibly displayed on the display. Particularly, the pointer is generated in a pointing signal processing unit, and an OSD generation unit **340** includes the pointing signal processing unit (not illustrated). Of course, it is also possible that instead of being providing within the OSD generation unit **340**, the pointing signal processing unit (not illustrated) is provided separately.

The mixer **345** mixes the OSD signal generated in the OSD generation unit **340**, and the image signal that results from the image processing and the decoding in the image processing unit **320**. An image signal that results from the mixing is provided to the frame rate converter **350**.

The frame rate converter (FRC) **350** converts a frame rate of an image input. On the other hand, it is also possible that the frame rate converter **350** outputs the image, as is, without separately converting the frame rate thereof.

On the other hand, the formatter **360** converts a format of the image signal input, into a format for an image signal to be displayed on the display, and outputs an image that results from the conversion of the format thereof.

The formatter **360** changes the format of the image signal. For example, a format of a 3D image signal is changed to any one of the following various 3D formats: a side-by-side format, a top and down format, a frame sequential format, an interlaced format, and a checker box format.

On the other hand, the audio processing unit (not illustrated) within the controller **170** performs audio processing of an audio signal that results from the demultiplexing. To do this, the audio processing unit (not illustrated) includes various decoders.

In addition, the audio processing unit (not illustrated) within the controller **170** performs processing for base, treble, volume adjustment and so on.

The data processing unit (not illustrated) within the controller **170** performs data processing of a data signal that results from the demultiplexing. For example, in a case where a data signal that results from the demultiplexing is a data signal the results from coding, the data signal is decoded. The data signal that results from the coding is an electronic program guide that includes pieces of broadcast information, such as a starting time and an ending time for a broadcast program that will be telecast in each channel.

On the other hand, a block diagram of the controller **170** illustrated in FIG. **3** is a block diagram for an embodiment of the present invention. Each constituent element in the block diagram is subject to integration, addition, or omission according to specifications of the image display controller **170** actually realized.

Particularly, the frame rate converter **350** and the formatter **360** may be provided separately independently of each other or may be separately provided as one module, without being provided within the controller **170**.

FIG. **4**A is a diagram illustrating a method in which the remote controller in FIG. **2** performs control.

In FIG. **4**A(a), it is illustrated that a pointer **205** which corresponds to the remote controller **200** is displayed on the display **180**.

The user moves or rotates the remote controller **200** upward and downward, leftward and rightward (FIG. **4**A(b)), and forward and backward (FIG. **4**A(c)). The pointer **205** displayed on the display **180** of the display device corresponds to movement of the remote controller **200**. As in the drawings, movement of the pointer **205**, which depends on the movement of the remote controller **200** in a 3D space, is displayed and thus, the remote controller **200** is named a spatial remote controller or a 3D pointing device.

FIG. **4**A(b) illustrates that, when the user moves the remote controller **200** leftward, the pointer **205** displayed on the display **180** of the display device correspondingly moves leftward.

Information on the movement of the remote controller **200**, which is detected through a sensor of the remote controller **200**, is transferred to the display device. The display device calculates the information on the movement of the remote controller **200** from coordinates of the pointer **205**. The display device displays the pointer **205** in such a manner that the pointer **25** corresponds to the calculated coordinates.

FIG. **4**A(c) illustrates a case where the user moves the remote controller **200** away from the display **180** in a state where a specific button within the remote controller **200** is held down. Accordingly, a selection area within the display **180**, which corresponds to the pointer **205**, is zoomed in so that the selection area is displayed in an enlarged manner. Conversely, in a case where the user causes the remote controller **200** to approach the display **180**, the selection area within the display **180**, which corresponds to the pointer **205**, is zoomed out so that the selection is displayed in a reduced manner. On the other hand, in a case where the remote controller **200** moves away from the display **180**, the selection area may be zoomed out, and in a case where the remote controller **200** approaches the display **180**, the selection area may be zoomed in.

On the other hand, an upward or downward movement, or a leftward or rightward movement is not recognized in a state where a specific button within the remote controller **200** is held down. That is, in a case where the remote controller **200** moves away from or approaches the display **180**, only a forward or backward movement is set to be recognized without the upward or downward movement, or the leftward or rightward movement being recognized. Only the pointer **205** moves as the remote controller **200** moves upward, downward, leftward, or rightward, in a state where a specific button within the remote controller **200** is not held down.

On the other hand, a moving speed or a moving direction of the pointer **205** corresponds to a moving speed or a moving direction of the remote controller **200**, respectively.

FIG. **4**B is a block diagram of the inside of the remote controller in FIG. **2**.

For description with reference to the drawings, the remote controller **200** includes a wireless communication unit **420**, a user input unit **430**, a sensor unit **440**, an output unit **450**, a power supply unit **460**, a memory **470**, and a controller **480**.

The wireless communication unit **420** transmits and receives a signal to and from an arbitrary one of the display devices according to the embodiments of the present invention, which are described above. Of the display devices according to the embodiments of the present invention, one display device is taken as an example for description.

According to the present embodiment, the remote controller **200** includes an RF module **421** that transmits and receives a signal to and from the display device **100** in compliance with RF communication standards. In addition, the remote controller **200** includes an IR module **423** that possibly transmits and receives a signal to and from the display device **100** in compliance with IR communication standards.

According to the present embodiment, the remote controller **200** transfers a signal containing information on the movement of the remote controller **200** to the display device **100** through the RF module **421**.

In addition, the remote controller **200** receives a signal transferred by the display device **100**, through the RF module **421**. In addition, the remote controller **200** transfers a command relating to power-on, power-off, a channel change, or a volume change, to the display device **100**, through the IR module **423**, whenever needed.

The user input unit **430** is configured with a keypad, buttons, a touch pad, a touch screen, or so on. The user inputs a command associated with the display device **100** into the remote controller **200** by operating the user input unit **430**. In a case where the user input unit **430** is equipped with a physical button, the user inputs the command associated with the display device **100** into the remote controller **200** by performing an operation of pushing down the physical button. In a case where the user input unit **430** is equipped with a touch screen, the user inputs the command associated with the display device **100** into the remote controller **200** by touching on a virtual key of the touch screen. In addition, the user input unit **430** may be equipped with various types of input means operated by the user, such as a scroll key or a jog key, and the present embodiment does not impose any limitation on the scope of the present invention.

The sensor unit **440** includes a gyro sensor **441** or an acceleration sensor **443**. The gyro sensor **441** senses information on the movement of the remote controller **200**.

As an example, the gyro sensor **441** senses the information on operation of the remote controller **200** on the x-, y-, and z-axis basis. The acceleration sensor **443** senses information on the moving speed and so on of the remote controller **200**. On the other hand, a distance measurement sensor is further included. Accordingly, a distance to the display **180** is sensed.

The output unit **450** outputs an image or an audio signal that corresponds to the operating of the user input unit **430** or corresponds to a signal transferred by the display device **100**. Through the output unit **450**, the user recognizes whether or not the user input unit **430** is operated or whether or not the display device **100** is controlled.

As an example, the output unit **450** includes an LED module **451**, a vibration module **453**, an audio output module **455**, or a display module **457**. The LED module **451**, the vibration module **453**, the audio output module **455**, and the display module **457** emits light, generates vibration, outputs audio, or outputs an image, respectively, when the input unit **435** is operated, or a signal is transmitted and received to and from the display device **100** through a wireless communication unit **420**.

The power supply unit **460** supplies a power to the remote controller **200**. In a case where the remote controller **200** does not move for a predetermined time, the power supply unit **460** reduces power consumption by interrupting power supply. In a case where a predetermined key provided on the remote controller **200** is operated, the power supply unit **460** resumes the power supply.

Various types of programs, pieces of application data, and so on that are necessary for control or operation of the remote controller **200** are stored in the memory **470**. In a case where the remote controller **200** transmits and receives a signal to and from the display device **100** in a wireless manner through the RF module **421**, the signal is transmitted and received in a predetermined frequency hand between the remote controller **200** and the display device **100**. The controller **480** of the remote controller **200** stores information on, for example, a frequency band in which data is transmitted and received in a wireless manner to and from the display device **100** paired with the remote controller **200**, in the memory **470**, and makes a reference to the stored information.

The controller **480** controls all operations associated with the control by the remote controller **200**. The controller **480** transfers a signal that corresponds to operating of a predetermined key of the user input unit **430**, or a signal that corresponds to the movement of the remote controller **200**, which is sensed in the sensor unit **440**, to the display device **100** through the wireless communication unit **420**.

A user input interface **150** of the display device **100** includes a wireless communication unit **411** that transmits and receives a signal in a wireless manner to and from the remote controller **200**, and a coordinate value calculator **415** that calculates a coordinate value of the pointer, which corresponds to the operation of the remote controller **200**.

The user input interface **150** transmits and receives the signal in a wireless manner to and from the remote controller **200** through the RF module **412**. In addition, a signal transferred in compliance with the IR communication standards by the remote controller **200** through the IR module **413** is received.

The coordinate value calculator **415** calculates a coordinate value (x, y) of the pointer **205** to be displayed on the display **180**, which results from compensating for a hand movement or an error, from a signal that corresponds to the operation of the remote controller **200**, which is received through the wireless communication unit **411**.

A transfer signal of the remote controller **200**, which is input into the display device **100** through the user input interface **150** is transferred to the controller **170** of the display device **100**. The controller **170** determines information on the operation of the remote controller **200** and information on operating of a key, from the signal transferred by the remote controller **200**, and correspondingly controls the display device **100**.

As another example, the remote controller **200** calculates a coordinate value of a pointer, which corresponds to the operation of the remote controller **200**, and outputs the calculated value to the user input interface **150** of the display device **100**. In this case, the user input interface **150** of the display device **100** transfers information on the received coordinate values of the pointer, to the controller **170**, without performing a process of compensating for the hand movement and the error.

In addition, as another example, unlike in the drawings, it is also possible that the coordinate value calculator **415** is included within the controller **170** instead of the user input interface **150**.

FIG. **5** is a block diagram illustrating an inner part of the power supply and the display of FIG. **2**.

Referring to drawings, the display module **180** based on a liquid crystal panel (LCD) panel may include a liquid crystal display panel **210**, a driving circuit **230**, a backlight unit **250**, an a backlight dimming controller **510**.

The liquid crystal panel **210** has a plurality of gate lines GL and data lines DL crossing each other in a matrix form, and includes a first substrate, in which a thin film transistor and a pixel electrode connected to the thin film transistor are formed at the crossing area, a second substrate including a common electrode, and a liquid crystal layer interposed between the first substrate and the second substrate.

The driving circuit **230** drives the liquid crystal display panel **210** based on a control signal and a data signal supplied from the controller **170** of FIG. **1**. To this end, the driving circuit **230** includes a tinting controller **232**, a gate driver **234**, and a data driver **236**.

The timing controller **232** receives the control signal and an R, G, and B signals, and a vertical synchronization (Vsync) signal from the controller **170** to control the gate driver **234** and the data driver **236**, in response to the control signal, re-arranges the R, G, and B data signals, and provides the R, G, and B signals to the data driver **236**.

A scan signal and an image signal are supplied to the liquid crystal display panel **210** through the gate line GL and the data line DL, in response to the control of the gate driver **234**, the data driver **236**, and the timing controller **232**.

The backlight unit **250** supplies light to the liquid crystal display panel **210**. To this end, the backlight unit **250** may include a plurality of light sources **252**, a scan driver **254**, which controls the scanning driving of the light source **252**, and a light source driver **256** which turns On/Off the light source **252**.

A specific image is displayed by using light output from the backlight unit **250**, in the state that the light transmittance of the liquid crystal layer is adjusted by an electric generated formed between a pixel electrode and a common electrode of the liquid crystal display panel **210**.

The power supply **190** may supply a common electrode voltage Vcom to the liquid crystal panel **210**, and may supply a gamma voltage to the data driver **236**. In addition, driving power may be supplied to the backlight unit **250** to drive the light source **252**.

Meanwhile, the backlight unit **250** is divided into a plurality of blocks for driving. The controller **170** may control the display **180** to perform local dimming by setting a dimming value for each of the plurality of blocks. In detail, the timing controller **232** may output input image data RGB to the backlight dimming controller **510**, and the backlight dimming controller **510** may calculate the dimming value of each of the plurality of blocks, based on the input image data RGB received from the timing controller **232**.

FIG. **6** is a view illustrating a liquid crystal display panel and the arrangement of light sources in the case of an edge type backlight unit, and FIG. **7** is a view illustrating a liquid crystal display panel and the arrangement of light sources in the case of a direct type backlight unit.

The liquid crystal display panel **210** may be divided into a plurality of virtual blocks as illustrated in FIGS. **6** and **7**. Although FIGS. **6** and **7** illustrate that the liquid crystal display panel **210** is uniformly divided into 16 blocks BL**1** to BL**16**, the present disclosure is not limited thereto. Each of the plurality of blocks may include a plurality of pixels.

The backlight unit **250** may be implemented in one of an edge type and a direct type.

The edge type backlight unit **250** has a structure in which a plurality of optical sheets and a light guide plate are stacked under the liquid crystal display panel **210**, and a plurality of light sources are arranged on a side surface of the light guide plate. When the backlight unit **250** is implemented as an edge type backlight unit, the light sources are disposed on at least one of top and bottom surfaces of the liquid crystal display panel **210** and on at least one of left and right side surfaces of the liquid crystal display panel **210**. FIG. **6** illustrates that a first light source array LA**1** is disposed on the top surface of the liquid crystal display panel **210** and a second light source array LA**2** is disposed on the left side surface of the liquid crystal display panel **210**. Each of the first light source array LA**1** and the second light source array LA**2** includes a plurality of light sources **252** and a light circuit board **251** on which the light sources **252** are mounted. In this case, the brightness of light incident onto a first block BL**1** of the liquid crystal display panel **210** may be adjusted by using light sources **252**A of the first light source array LA**1** and light sources **252**B of the second light source array LA**2**, which are positioned to correspond to the first block BL**1** of the liquid crystal display panel **210**.

The direct type backlight unit **250** has a structure in which a plurality of optical sheets and a diffusion plate are stacked under the liquid crystal display panel **210** and a plurality of light sources are disposed under the diffusion plate. When the backlight unit **250** is implemented as the direct type backlight unit, the backlight unit **250** is divided to one-to-one correspond to the blocks BL**1** to BL**16** of the liquid crystal display panel **210** as illustrated in FIG. **7**. In this case, the brightness of light incident onto the first block BL**1** of the liquid crystal display panel **210** may be adjusted by using the light sources **252** included in the first block B**1** of the backlight unit **250**, which is disposed at a position corresponding to the first block BL**1** of the liquid crystal display panel **210**.

The light sources **252** may be implemented as point light sources such as a light emitting diode (LED). The light sources **252** are turned on and off by receiving light source driving signals LDS from the light source driver **256**. The intensity of light of the light sources **252** may be adjusted depending on the amplitudes of the light source driving signals LDS, and a lighting duration may be adjusted depending on a pulse width. The brightness of light output from the light sources **252** may be adjusted depending on the light source driving signals LDS.

The light source driver **256** may generate the light source driving signals LDS, based on a dimming value of each of the blocks, which is input from the backlight dimming controller **510** and output the generated dimming signals LDS to the light source **252**. The dimming values of the blocks may be values for implementing local dimming and may be brightness of light output from the light sources **252**.

The controller **170** may perform a variable refresh rate (VRR) function.

The VRR function may be a function of adjusting a refresh rate of a screen depending on an image signal.

The screen refresh rate may refer to the number of frequencies in which the display **180** displays a frame for one second. In other words, the refresh rate of the screen may be a numerical value indicating the number of scenes output by the display **180** for one second.

The screen refresh rate may be a scan rate or a screen refresh rate.

The controller **170** may perform the VRR function under a specific condition. For example, the controller **170** may perform the VRR function in the game mode. In addition, the controller **170** may perform the VRR function, when receiving an image signal from an external device through the external device interface **135**. In addition, the controller **170** may perform the VRR function, when determining a frame per second (FPS) of the image signal as not being constant, based on a processing result of the image signal. Alternatively, the controller **170** may perform the VRR function, when receiving a command for performing the VRR function through the user input interface **150**. However, the above cases are provided for the illustrative purpose, and the controller **170** may perform the VRR function in various manners.

The controller **170** may acquire a vertical synchronizing signal, based on the image signal while performing the VRR function. In other words, the controller **170** may extract the vertical synchronizing signal Vsync by decoding the image signal.

The vertical synchronizing signal may be a signal for matching a starting point to scan one field in a transmitter and a receiver.

The controller **170** may acquire a vertical synchronizing signal having a constant frequency, when the controller **170** does not perform the VRR function. Accordingly, in this case, the screen refresh rate may be constant, and the number of frames, which are displayed by the display **180** per second may be constant. For example, the controller **170** may display 60 frames per second, when the VRR function is not performed.

However, the controller **170** extracts the vertical synchronizing signal, based on an image signal when performing the VRR function. In this case, the frequency of the vertical synchronizing signal may be varied depending on the number of frames of the image signal per second. Accordingly, in this case, the number of frames, which are displayed by the display **180**, per second may be varied.

FIG. **8** is a view illustrating a method in which the display device controls a vertical synchronizing signal and local dimming, based on an image signal while performing a VRR function.

In detail, the controller **170** may extract the vertical synchronizing signal Vsync, based on an image signal, which is received, when the controller **170** is performing the VRR function and when the image signal is input.

Referring to FIG. **8**, according to the result obtained by acquiring the vertical synchronizing signal based on the image signal by the controller **170**, the frequency of the vertical synchronizing signal may be consecutively changed to 120 Hz, 120 Hz, 58 Hz, and 70 Hz.

When the VRR function is being executed, the frequency of the vertical synchronizing signal may be changed between about 48 Hz and 120 Hz.

In other words, the controller **170** may control the backlight unit **250** depending on the vertical synchronizing signal. In other words, the controller **170** may recognize the frequency of the vertical synchronizing signal as an operating frequency of the backlight unit **250**, and the backlight unit **250** may operate depending on the vertical synchronizing signal. In this case, when the frequency of the vertical synchronizing signal is excessively low (for example, the frequency of the vertical synchronizing signal is about 55 Hz or less), a user may recognize a flicker.

In addition, in the conventional display device **100**, the backlight dimming controller **510** calculates local dimming data in a specific period regardless of the vertical synchronizing signal, and controls the local dimming, based on the calculated local dimming data.

The local dimming data may refer to a dimming value of each of blocks, which is extracted based on image data for local dimming. Accordingly, the local dimming data may be varied depending on the variation of the image data.

However, as in a conventional technology, when the controller **170** calculates local dimming data in the specific period and controls local dimming, even though image data is changed, the controller **170** controls the local dimming based on local dimming data based on a previous image frame, so the contrast of an image is not enhanced or deteriorated. In other words, when the VRR function is performed, the local dimming is not sufficiently performed.

According to an embodiment of the present disclosure, the display device **100** increases a screen refresh rate adjusted depending on an image signal to improve a flicker problem, and controls local dimming depending on the adjusted/increased screen refresh rate, such that the local dimming is performed to be matched to an image even in the VRR function.

FIG. **9** is a flowchart illustrating an operating method of a display device according to an embodiment of the present disclosure.

The controller **170** may perform the VRR function (S**11**).

The controller **170** may determine whether the VRR function is being performed, may fix the screen refresh rate when the VRR function is not performed, and may change the screen refresh rate depending on an image signal. Hereinafter, the above method will be described in detail.

The controller **170** may adjust the screen refresh rate based on the image signal, when the VRR function is being performed (S**13**).

In more detail, when the VRR function is being performed, the controller **170** may acquire the number of frames per second of the image signal and may extract the frequency of the vertical synchronizing signal, based on the number of frames per second of the image signal.

In particular, the image decoder **320** may acquire the number of frames per second of the image signal by decoding the image signal, may extract the vertical synchronizing signal based on the number of frames per second, and may acquire the screen refresh rate. The frame rate converter **350** may change a frame rate depending on the screen refresh rate acquired through the image decoder **320**. In addition, the frame rate converter **350** may increase the screen fresh rate acquired by the screen image decoder **430**, and may change the frame rate depending on the increased screen refresh rate when the screen refresh rate is increased.

FIG. **10** is a view illustrating output timing of a vertical synchronizing signal Vsync and local dimming data depending on an image signal while a display device is performing the VRR function according to an embodiment of the present disclosure.

For example, the controller **170** may extract the frequency of the vertical synchronizing signal as 120 Hz when the number of frames per second of the image signal is 120, may extract the frequency of the vertical synchronizing signal as 58 Hz, when the number of frames per second of the image signal is 58, and may extract the frequency of the vertical synchronizing signal as 70 Hz, when the number of frames per second of the signal is 70.

The controller **170** may adjust the screen refresh rate depending on the frequency of the vertical synchronizing signal.

The screen refresh rate may refer to the number of frames, which is displayed by the display **180**, for one second, and the unit of the screen refresh rate may be hertz (Hz) referring to repetition per second. Accordingly, the screen refresh rate may be the frequency of the vertical synchronizing signal.

Accordingly, the controller **170** may adjust the screen refresh rate depending on the number of frames per second of the image signal. For example, the controller **170** may adjust the screen refresh rate as 120 Hz, when the number of frames per second of the image signal is 120, may adjust the screen refresh rate as 58 Hz, when the number of frames per second of the image signal is 58, and may adjust the screen refresh rate as 70 Hz, when the number of frames per second of the image signal is 70.

In this case, the controller **170** may control local dimming depending on the adjusted screen refresh rate. In other words, the controller **170** may calculate local dimming data to be matched to the vertical synchronizing signal, and may control local dimming depending on the calculated data.

Referring to FIG. **10**, a dotted line shown on the local dimming data may represent data calculated and applied in a specific period regardless of a conventional vertical synchronizing signal, and a solid line may represent data calculated and applied in response to the vertical synchronizing signal according to the present disclosure.

In this case, the local dimming is performed to be matched to an image frame currently displayed on the display **180**.

However, as described above, when the screen refresh rate is adjusted to a specific frequency or less, the flicker is not caused.

Accordingly, the controller **170** may increase the adjusted screen refresh rate.

The following description will be made with reference to FIG. **9** again.

The controller **170** may multiply the adjusted screen refresh rate (S**15**).

In detail, the controller **170** may increase the adjusted screen refresh rate in various manners depending on the image signal, and one of the manners is to multiply the adjusted screen refresh rate.

In other words, the controller **170** may increase the adjusted screen refresh rate to a frequency corresponding to an integer multiple thereof, depending on the image signal.

For example, the controller **170** may increase the screen refresh rate to be twice, but is provided for the illustrative purpose. In other words, the controller **170** may increase the screen refresh rate to be four times or more.

Meanwhile, according to a first embodiment, the controller **170** may unconditionally increase a screen refresh rate adjusted depending on the image signal while performing the VRR function.

For example, when the screen refresh rate is sequentially adjusted to 120 Hz, 120 Hz, 58 Hz, or 70 Hz while performing the VRR function, the controller **170** may multiply the adjusted screen refresh rate of 120 Hz, 120 Hz, 58 Hz, or 70 Hz to 240 Hz, 240 Hz, 116 Hz, or 140 Hz, respectively.

According to the second embodiment, the controller **170** may increase the screen refresh rate, only when the screen refresh rate, which is adjusted depending on the image signal while the VRR function is being performed, is equal to or less than a preset frequency. In this case, the controller **170** may maintain the screen refresh rate adjusted depending on the image signal, when the screen refresh rate adjusted depending on the image signal exceeds the preset frequency.

For example, the controller **170** may set, to 55 Hz, a frequency serving as a reference for increasing a screen refresh rate. In other words, in this case, the controller **170** may increase the screen refresh rate, when the screen refresh rate adjusted depending on the image signal is 55 Hz.

For example, when sequentially adjusting the screen refresh rate to 120 Hz, 120 Hz, 58 Hz, or 70 Hz while the VRR function is being performed, the controller **170** may maintain or multiply the adjusted screen refresh rate of 120 Hz, 120 Hz, 58 Hz, or 70 Hz to 120 Hz, 120 Hz, 116 Hz, or 40 Hz.

Meanwhile, the frequency serving as the reference for increasing the screen refresh rate is set to 55 Hz by way of example, but the present disclosure is not limited thereto.

The controller **170** may set an arbitrary frequency expected to cause the flicker, to the frequency serving as the reference for increasing the screen refresh rate.

The controller **170** may receive an installation environment or a use environment of the display device **100** to set the frequency serving as the reference for increasing the screen refresh rate.

For example, when a current time is a night time band (for example, the time period ranging from 17:00 p.m. to 5:00 a.m.), the controller **170** may set the frequency serving as the reference for increasing the screen refresh rate to a first frequency (for example, 40 Hz). When the current time is a day time band (for example, the time period ranging from 5:00 a.m. to 17:00 a.m.), the controller **170** may set the frequency serving as the reference for increasing the screen refresh rate to a second frequency (for example, 55 Hz) higher than the first frequency.

However, a method for changing the frequency serving as the reference for increasing the screen refresh rate, depending on the time band as described above is provided for the illustrative purpose.

For another example, when the set brightness of the display device **100** is less than a reference value (for example, 50 in the range of 1 to 100), the controller **170** may set the frequency serving as the reference for increasing the screen refresh rate to the first frequency (for example, 40 Hz). When the set brightness of the display device **100** is equal to or greater than a reference value (for example, 50 in the range of 1 to 100), the controller **170** may set the frequency serving as the reference for increasing the screen refresh rate to the second frequency (for example, 55 Hz) higher than the first frequency.

As described above, according to various embodiments, the controller **170** may increase the screen refresh rate to the second frequency higher than the first frequency, when the screen refresh rate is acquired to the first frequency based on the image signal.

FIG. **11** is a view illustrating output timing of a vertical synchronizing signal Vsync and local dimming data, after multiplying the vertical synchronizing signal Vsync depending on an image signal, while a display device performs a VRR function according to an embodiment of the present disclosure.

As illustrated in FIG. **11**, the controller **170** may increase the screen refresh rate to be twice.

For example, the controller **170** may increase the screen refresh rate from 120 Hz to 240 Hz, when the number of frames per second of the image signal **120**, may increase the screen refresh rate from 58 Hz to 116 Hz, when the number of frames per second of the image signal **58**, and may increase the screen refresh rate from 70 Hz to 140 Hz, when the number of frames per second of the image signal **70**. In this case, the controller **170** may increase a transmission frequency of a vertical synchronizing signal to be twice. Accordingly, even the frequency for controlling local dimming may be adjusted to be identical to the vertical synchronizing signal.

The following description will be made with reference to FIG. **9** again.

The controller **170** may control the backlight unit **250** and the local dimming depending on the multiplied screen refresh rate (S**17**).

The backlight unit **250** and the backlight dimming controller **510** may be drive depending on the screen refresh rate increased by the frame rate converter **350**.

The controller **170** may increase the operating frequency of the backlight unit depending on the multiplied screen refresh rate. In other words, the controller **170** may increase the transmission frequency of the vertical synchronizing signal identically to the screen refresh rate, by increasing the screen refresh rate. In this case, as the transmission frequency of the vertical synchronizing signal is increased, the operating frequency of the backlight unit **250** provided in the display **180** may be increased together.

For example, on the assumption that the number of frames per second of the image signal is in the range of about 48 frames to 120 frames, the controller **170** may increase the screen refresh rate from 98 Hz to 240 Hz by multiplying the screen refresh rate to be twice. Accordingly, since the screen refresh rate is at least 98 Hz, even the frequency of the vertical synchronizing signal is at least 98 Hz. Accordingly, since even the operating frequency of the backlight unit **250** is at least 98 Hz, the user may minimize the case of experiencing the flicker phenomenon.

In addition, the controller **170** may increase a frequency for calculating local dimming data by increasing the screen refresh rate.

In detail, the controller **170** may multiply the vertical synchronizing signal, as the screen refresh rate is multiplied, and may calculate and control local dimming data in response to the multiplied vertical synchronizing signal. In this case, a plurality of local dimming data for an image displayed for one second may be calculated. For example, when the vertical synchronizing signal is multiplied to be twice, two pieces of local dimming data may be calculated with respect to an image displayed for one second.

Referring to FIG. **11**, a dotted line illustrated on the local dimming data may represent data calculated and applied in a specific period regardless of the conventional vertical synchronizing signal, and a solid line may represent data calculated and applied in response to the vertical synchronizing signal according to the present disclosure.

As described above, when calculating and applying the local dimming data in response to the multiplied vertical synchronizing signal, the controller **170** may control local dimming based on the local dimming data which is first calculated, and may not process local dimming data which is second calculated. In other words, the controller **170** may apply only the local dimming data, which is first calculated, to the display **180**, and may not apply the local dimming data, which is second calculated, to the display **180**.

As the controller **170** multiplies the vertical synchronizing signal, the controller **170** may calculate a plurality of local dimming data. In this case, since the same image signal is used, a plurality of identical local dimming data may be calculated. Accordingly, when the controller **170** multiples the vertical synchronizing signal, the controller **170** may control the backlight dimming controller **510** to perform local dimming based on the local dimming data which is first calculated, and may not process the local dimming data which is second calculated.

As described above, the controller **170** may calculate the local dimming data and control local dimming, in response to the vertical synchronizing signal such that the local dimming to be matched to the image signal is performed regardless of the change in frame of the image signal. In addition, a load for processing data may be reduced by processing only the local dimming data which is first calculated.

FIG. **12** is a view illustrating an image when a screen refresh rate, which is adjusted, is not increased or an image when a screen refresh rate is increased, after the screen refresh rate is adjusted when a display device is performing a VRR function according to an embodiment of the present disclosure.

FIG. **12**A illustrates an image obtained by capturing one scene of an image output, when a conventional display device performs a VRR function, and FIG. **12**B illustrates an image obtained by capturing the same scene while outputting the same image as that of FIG. **12**A, when a display device according to an embodiment of the present disclosure performs a VRR function.

As illustrated in FIG. **12**, the conventional display device outputs an image having a lower contrast, as the conventional display device does not apply the local dimming to be matched to the image, which is currently output, while the display device according to an embodiment of the present disclosure outputs an image having a higher contrast, as the display device according to an embodiment of the present disclosure applies the local dimming to be matched to the image which is currently output.

In addition, in the display device according to an embodiment of the present disclosure, the backlight unit **250** is driven to be matched to be a time point at which the image frame is changed. Accordingly, the image is smoothly changed and the image quality is improved.

The above description is merely illustrative of the technical idea of the present disclosure, and various modifications and changes may be made thereto by those skilled in the art without departing from the essential characteristics of the present disclosure.

Therefore, the embodiments of the present disclosure are not intended to limit the technical spirit of the present disclosure but to illustrate the technical idea of the present disclosure, and the technical spirit of the present disclosure is not limited by these embodiments.

The scope of protection of the present disclosure should be interpreted by the appending claims, and all technical ideas within the scope of equivalents should be construed as falling within the scope of the present disclosure.

The invention claimed is:

1. A display device comprising:

a display,

a controller operatively connected to the display,

wherein the controller is configured to:

receive a sequence of images,

extract, from each image of the sequence of images, an image specific frequency of a vertical synchronizing signal of a corresponding image,

determine whether or not one of the extracted image specific frequencies is below a threshold frequency while another one of the extracted image specific frequencies is not below the threshold frequency, and

upon determining that one of the extracted image specific frequencies is below the threshold frequency while the another one of the extracted image specific frequencies is not below the threshold frequency:

increase an image specific screen refresh rate of all images of the sequence of images by a common factor, and

control the display to display the sequence of images with the image specific screen refresh rate that has been increased by the common factor.

2. The display device of claim **1**, wherein the threshold frequency is 55 Hz.

3. The display device of claim **1**, wherein the controller is configured to:

upon determining that none of the extracted image specific frequencies is below the threshold frequency:

maintain the image specific screen refresh rate of all images of the sequence of images, and

control the display to display the sequence of images with the image specific screen refresh rate that has been maintained.

4. The display device of claim **1**, wherein the image specific frequency of the vertical synchronizing signal is extracted based on an image specific number of frames per second.

5. The display device of claim **4**, wherein the controller includes:

an image decoder to acquire the image specific number of frames per second by decoding the image signal, and to acquire the image specific screen refresh rate based on the image specific number of frames per second; and

a frame rate converter to increase the image specific screen refresh rate acquired by the common factor, and

wherein the display includes a backlight unit and a backlight dimming controller that are driven based on the image specific screen refresh rate of all images of the sequence of images that has been increased by the common factor.

6. The display device of claim **1**, wherein the controller is configured to:

increase an operating frequency of a backlight unit provided in the display based on the increase of the image specific screen refresh rate.

7. The display device of claim **1**, wherein the controller is configured to:

increase a frequency for calculating local dimming data based on the increase of the image specific screen refresh rate.

8. The display device of claim **7**, wherein the controller is configured to:

apply local dimming to the sequence of images based on the increase of the image specific screen refresh rate.

9. The display device of claim 1, further comprising:
an external device interface connected to an external device which provides the sequence of images.

10. An operating method of a display device, the operating method comprising:
receiving a sequence of images;
extracting, from each image of the sequence of images, an image specific frequency of a vertical synchronizing signal of a corresponding image;
determining whether or not one of the extracted image specific frequencies is below a threshold frequency while another one of the extracted image specific frequencies is not below the threshold frequency; and
upon determining that one of the extracted image specific frequencies is below the threshold frequency while the another one of the extracted image specific frequencies is not below the threshold frequency:
increasing an image specific screen refresh rate of all images of the sequence of images by a common factor; and
displaying the sequence of images with the image specific screen refresh rate that has been increased by the common factor.

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